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PATENT ABSTRACTS OF JAPAN

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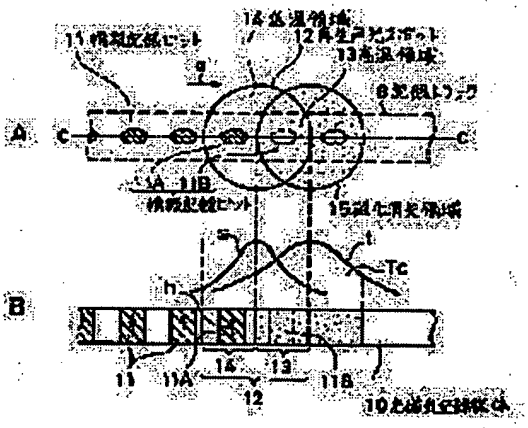
(54) MAGNETO-OPTICAL RECORDING AND REPRODUCING METHOD

(57)Abstract:

PURPOSE: To provide a recording and reproducing method which performs a one shot reproduction, automatically erases the recording right after a reproduction, has a simple magnetic layer constitution of the magneto-optical recording medium and reproduces images with a ultra high resolution.

CONSTITUTION: During a recording, information recording pits 11, which include spacial frequency components that are more than the cutoff spacial frequency, are recorded against a magneto-optical recording medium 10. During a reproduction, a reproduction light power is selected so as to form a high temperature region 13 within a reproduction light spot 12 which erases information recording pits 11 and only the information recording pits 11 in the low temperature region 14, that excludes the high temperature 13 within the reproduction light spot 12, are reproduced by a magneto-optical effect.



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2.**** shows the word which can not be translated.
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to a magneto-optic-recording playback system and the magneto-optic-recording playback system which performs hyperresolution playback to magneto-optic-recording data medium by which high density record was made especially, for example.
[0002]
[Description of the Prior Art] An information record pit, i.e., a bubble domain, is formed with local heating by laser beam exposure, and in the magneto-optic-recording playback method which reads this recording information according to an optical MAG interaction, i.e., the Kerr effect, or the Faraday effect, although micrifying of that record pit will be achieved in order to raise the recording density of that magneto-optic recording, the resolution at the time of that playback (resolution) poses a problem in this case. This resolution is determined by the laser wavelength at the time of playback, and the numerical aperture NA of an objective lens, and recording density is restricted by the so-called cut-off spatial-frequency 2 NA/lambda.
[0003] Usually, a general magneto-optic-recording playback system is explained with reference to drawing 5 . Drawing 5 A shows the typical plan of a record pattern, and explains the playback method, magneto-optic-recording data medium 10, for example, the magneto-optic disk, with which the record pit 24 which attaches and shows a slash was recorded on the land 22 the both-sides fang furrow's 21, i.e., a groove, pinched according to "1" of binary information, or "0."
[0004] It sees now about the case where the beam spot on magneto-optic-recording data medium 10 of a read-out laser beam is a circular spot shown with a sign 26. When selection of a pit gap is made at this time so that only one record pit 24 can exist in the one beam spot 26 as shown in drawing 5 A, as shown in drawing 5 B or drawing 5 C, in a spot 6, there is the record pit 24, and it will suit, and those two modes will be taken. Therefore, when the record pit 24 is arranged at equal intervals, the output wave serves as for example, a sinusoidal output reversed to positive/negative to reference level 0, as shown for example, in drawing 5 D.
[0005] However, as the typical plan of a record pattern is shown in drawing 6 A, when the record pit 24 is arranged by high density, two or more record pits 24 enter in the beam spot 26. Since change will not arise in a playback output in the case where the record pits 24a and 24b which adjoin the one beam spot 26 enter, and the case where 24b and 24c enter as shown in drawing 6 B and drawing 6 C if it sees about now 24a, 24b, and 24c, for example, three adjacent record pits, as shown in drawing 6 D, the playback output wave becomes linear and cannot perform both discernment.
[0006] Thus, in the magneto-optic-recording playback system of the general former, since the record pit 24 recorded on magneto-optic-recording data medium 10 is read in the condition as it is, even if high density record, i.e., formation of a high density record pit, is possible, from constraint of the resolution at the time of the playback, the problem of S/N (C/N) arises and sufficient high density record playback cannot be performed.
[0007] Although it is necessary to aim at an improvement of the resolution at the time of playback in order to solve the problem of such an S/N (C/N), this resolution has the problem that it is restrained by laser wavelength, the numerical aperture of a lens, etc. As what aims at solution of such a trouble, these people proposed the hyperresolution (hyperresolution ability) magneto-optic-recording playback system (it is called Following MSR) previously (for example, JP,3-88156,A, JP,3-93058,A, JP,3-97140,A).
[0008] If this MSR is explained, as the record pit 24 of magneto-optic-recording data medium is generated only in a predetermined temperature field in the time of playback using the temperature distribution by the relative movement of magneto-optic-recording data medium and the beam spot 26 for playback, in this MSR, reproductive high resolution-ization will be achieved as a result.

[0009] as the example of this MSR method -- being the so-called -- it comes up and the playback system of a mold and the playback system of a disappearance mold can be considered.
[0010] It comes up first and the MSR method of a mold is explained with reference to drawing 7 . Drawing 7 A is the typical plan showing the record pattern of magneto-optic-recording data medium 10, and drawing 7 B is the typical cross section showing the magnetization mode. In this case, as shown in drawing 7 A, it is made as [move / to the beam spot 26 by the laser beam / magneto-optic-recording data medium 10 / relatively / direction / which is shown by the arrow head D]. It is used as shown in drawing 7 B in this case, magneto-optic-recording data medium 10, for example, the magneto-optic disk, which has the playback layer 31 which consists of perpendicular magnetic anisotropy films at least, and the record layer 33, has the middle class 32 who intervenes between both the layers 31 and 33 still more desirably, and changes. It is that the drawing solid line arrow head indicated the sense of the magnetic moment to be typically, facing down is "0" of an initial state, i.e., binary, or "1" in the example of illustration, and the information record pit 24 is formed in this at least as binary "1" or "0" with the magnetic domain by upward magnetization at the record layer 33 in drawing.
[0011] In such magneto-optic-recording data medium 10, if the playback mode is explained, first, from the exterior, the initialization magnetic field Hi will be impressed, and the playback layer 31 will be magnetized and initialized downward in drawing. That is, in the playback layer 31, although the record pit 24 disappears, since it is made as [hold / with the magnetic domain wall of the playback layer 31 and the record layer 33 produced in the interlayer 32 / at the reverse sense / the sense of magnetization], in the portion which has the record pit 24 at this time, the record pit 24 remains as a latent-image record pit 41.
[0012] On the other hand, the playback magnetic field Hr of the reverse sense is given at least to magneto-optic-recording data medium 10 in the playback section in the initialization magnetic field Hi. The field which has the latent-image record pit 41 initialized with migration of data medium 10 in this condition goes into the bottom of the beam spot 26. If it shifts to left-hand side in tip side drawing under the beam spot 26, since beam irradiation time will become long substantially, as a dashed line a surrounds and shows to the tip side of a spot 26 The elevated-temperature field 34 is generated substantially, in this field 34, an interlayer's 32 magnetic domain wall is extinguished, magnetization of the record layer 33 is imprinted by the playback layer 31 by that exchange force, and the latent-image record pit 41 which existed in the record layer 33 comes up as a record pit 24 which can be reproduced in the playback layer 33.
[0013] Therefore, if the rotatory polarization of the beam spot 26 by the Kerr effect by the sense or the Faraday effect of the magnetization in this playback layer 31 is detected, this record pit 24 can be read. And it sets to low-temperature fields 36 other than elevated-temperature field 34 in the beam spot 26 at this time. The latent-image record pit 41 will not come up to the playback layer 31, but will read only in the narrow elevated-temperature field 34 after all, and the possible record pit 24 will exist. When two or more record pits 24 enter in the beam spot 26 as a result, only the single record pit 24 can be read also in magneto-optic-recording data medium 10 of high density record, and high resolution playback can be performed.
[0014] Next, MSR of a disappearance mold is explained with reference to drawing 8 . Drawing 8 A is the typical plan showing the record pattern of magneto-optic-recording data medium 10, and drawing 8 B is the typical cross section showing the magnetization mode. In drawing 8 A and B, the same sign is given to the portion corresponding to drawing 7 A and drawing 7 B, and duplication explanation is omitted. In this case, the initialization magnetic field Hi is not needed.
[0015] In this case, the material of laser beam power or the middle class 32 is selected so that it may become in the elevated-temperature field 34 more than the middle class's 32 Curie point. In drawing, magnetization is arranged downward by the playback magnetic field Hr impressed from the outside in the elevated-temperature field 34 in the laser beam spot 26 by this, and it is made for the record pit 24 in the playback layer 31 to disappear. Also in the condition that this interlayer's 32 magnetization disappeared on the other hand, terms and conditions, such as coercive force of this record layer 33, are set up so that the record pit 24 may remain as a latent-image record pit 41 in the record layer 33.
[0016] On the other hand in the low-temperature field 34, it is made as [hold / in the refreshable condition / the playback layer 31 imprints, magnetization 24, i.e., the record pit, of the record layer 33, and]. That is, by this disappearance mold MSR method, as playback about the record pit in the low-temperature field 36 of the beam spot 26 can be performed, improvement in resolution is aimed at.
[0017] Since the **** came up, and the record pit in some fields of the playback laser beam spot was reproduced according to the MSR method of a mold and a disappearance mold, improvement in the resolution at the time of playback is aimed at.
[0018] However, as mentioned above, in these MSR(s) method, it is necessary to make the magnetic layer of magneto-

optic-recording data medium into multilayer structure, and there is a possibility that un-arranging [that the flexibility of material selection is low] may arise intricately [the structure].
[0019] Since it remains as it is, without eliminating the contents of record only by reproducing recording information, that playback is required once, and it is the purposes, such as a security protection, after that, and general magneto-optic-recording data medium on the other hand usually takes time and effort, such as eliminating a recording track and going, using a special magnetic eraser, to have eliminated these contents of record.
[0020]
[Problem(s) to be Solved by the Invention] Especially this invention offers the record playback method which can take easy magnetic layer structure and can reproduce a hyperresolution after this one playback of what needs only one playback in magneto-optic-recording data medium used when recording information needs to be eliminated, without making the magnetic layer of magneto-optic-recording data medium into complicated structure as in the MSR method mentioned above.
[0021]
[Means for Solving the Problem] ****-explanatory drawing of an example of this invention magneto-optic-recording playback method is shown in drawing 1 . As this invention is shown in drawing 1 , magneto-optic-recording data medium 10 is received at the time of record. Record of the information record pit 11 containing a spatial-frequency component more than cut-off spatial frequency Nothing, It selects to optical power for playback which forms the elevated-temperature field 13 which vanishes the information record pit 11 in the optical spot 12 for playback at the time of playback, and only the information record pit 11 in the low-temperature field 14 except the elevated-temperature field 13 in the optical spot 12 for playback is reproduced according to the magneto-optical effect.
[0022]
[Function] this invention magneto-optic-recording playback method uses the temperature distribution on magneto-optic-recording data medium 10 produced in the optical spot 12 for playback. It is magneto-optic-recording data medium by which the information record pit 11 (11A, 11B ....) where 10 contains the spatial-frequency component more than cut-off spatial frequency was recorded in drawing 1 A. If this magneto-optic-recording data medium 10 shifts to the travelling direction shown by the arrow head a in drawing 1 A, just before entering into the optical spot 12 for playback, temperature will rise by laser beam exposure from from. With the relation of heat conduction Temperature distribution to which a front field serves as a maximum temperature from the center of the strongest optical spot 12 for playback of exposure reinforcement a little arise.
[0023] The ****-expanded sectional view on the C-C line in drawing 1 A is shown in drawing 1 B. The continuous line arrow head h is what showed typically the magnetic moment in magneto-optic-recording data medium 10, shows the temperature distribution by the exposure of the above-mentioned spot 12 as a continuous line t, and shows the optical intensity distribution of the optical spot 12 for playback as a continuous line s. At this time, the relative shift speed to the spot 12 of magneto-optic-recording data medium 10, and by selecting the optical power for playback etc. appropriately As produced the elevated-temperature field 13 beyond predetermined temperature, and the low-temperature field 14 of under predetermined temperature and further existed in the low-temperature field 13 in a spot 12 only in one of two or more information record pits in a spot 12, the range which each fields 13 and 14 occupy can be selected.
[0024] And since the optical power for playback is selected so that information record pit 11B may disappear in the elevated-temperature field 13 produced in this spot 12 at the time of playback, only one information record pit 11A in the low-temperature field 14 is reproducible [by using this elevated-temperature field 13 as a mask] in especially this invention method, among two or more information record pits in a spot 12 with the magneto-optical effect.
[0025] Moreover, since magnetization disappearance of the information pit is carried out into the elevated-temperature field 13 in this way, so to speak, initialization of magneto-optic-recording data medium 10 will be automatically performed immediately after playback. That is, only one playback is made and the contents of record disappear, without needing special elimination actuation after that.
[0026]
[Example] With reference to drawing 1 - drawing 4 , each example of this invention magneto-optic-recording playback method is explained below. In this example, while each example makes a laser beam irradiate the predetermined location of magneto-optic-recording data medium 10 with a condenser lens 16 so that the block diagram of an example of a record regenerative apparatus which enforces this invention method to drawing 2 may be shown, it reads that reflected light and performs record playback. In this example, it is made to magneto-optic-recording data medium 10 as impress / at the time of playback / in the time of record, or a certain case / by the magnetic field generating means 9 / an external magnetic field Hex].

[0027] Magneto-optic-recording data medium 10 consists of SiN etc. for example, on the substrate 1 of the light transmission nature which consists of a polycarbonate etc., consists of thickness 2, for example, a 1100A dielectric layer, TbFeCo, etc., consists of thickness 3, for example, a 300A magnetic layer, SiN, etc., consists of thickness 4, for example, a 450A dielectric layer, aluminum, etc., and covering formation of thickness 5, for example, the 700A thermal control layer, is carried out by sputtering etc. one by one, and it changes.
[0028] In such an equipment configuration, high density record which has a frequency component more than cut-off spatial frequency to magneto-optic-recording data medium 10 first is performed.
[0029] The playback method for this magneto-optic-recording data medium 10 is explained with reference to drawing 1 . In drawing 1 , in order to vanish an information record pit, it is the case where a temperature up is carried out more than the Curie temperature to which magnetization disappears in the elevated-temperature field 13. As mentioned above, record of high density is made on the recording track 8 of magneto-optic-recording data medium 10, and it is made as [enter / in the optical spot 12 for playback / two information record pits 11A and 11B].
[0030] If magneto-optic-recording data medium 10 shifts to the travelling direction shown by the arrow head a by the exposure of the light for playback at this time, as mentioned above, temperature will rise by the exposure of the light for playback, and temperature distribution to which a front field serves as a maximum temperature from the center of the optical spot 12 for playback a little with the relation of heat conduction will arise.
[0031] And as a continuous line t shows drawing 1 B in this case, the optical power for playback is selected so that a certain field which contains a part of spot 12 according to this temperature up may become more than Curie-temperature Tc of a magnetic layer 3, namely, so that it may become the magnetization disappearance field 15 where magnetization disappears. That is, in a spot 12, the elevated-temperature field 13 where it is a part of magnetization disappearance field 15, and a magnetic layer 3 becomes more than Curie temperature, and the low-temperature field 14 of under Curie temperature are produced. And further, on the recording track 8 in this low-temperature field 14, the shift speed of magneto-optic-recording data medium 10 or the material of a magnetic layer 3 or the thermal control layer 5, thickness, etc. are appropriately selected so that only one information record pit 11A may exist and only pit 11B which passed through the low-temperature field 14 may enter in the elevated-temperature field 13.
[0032] Thus, since magnetization can be vanished, namely, a mask can be carried out by making information record pit 11B enter the elevated-temperature field 13 which becomes more than Curie temperature among two or more information record pits in a spot 12, only one information record pit 11A can be read according to the magneto-optical effect, and a hyperresolution can be reproduced with an easy magneto-optic-recording data-medium configuration.
[0033] Moreover, after playback, since this read information record pit 11A enters the elevated temperature field 13 by shift of magneto-optic recording data medium 10, when record elimination will be automatically performed immediately after playback, and it can initialize, without establishing any special means and recording information needs to be eliminated after playback, simplification of a record regenerative apparatus is achieved and the thing of it can be carried out.
[0034] Next, with reference to drawing 3 A and B, other examples of this invention magneto-optic-recording playback method are explained. In drawing 3 A and B, the same sign is given to the portion corresponding to drawing 1 A and B, and duplication explanation is omitted. In this example, temperature is set up so that magneto-optic-recording data medium 10 in the elevated-temperature field 13 may become beyond the so-called flux reversal temperature to which the sense of magnetization gathers in the direction of an external magnetic field and may become under Curie temperature, and at the time of playback, it makes as [impress / with the magnetic field generating means 9 shown in drawing 2 / an external magnetic field Hex].
[0035] By also in this case, the case where two information record pits 11A and 11B exist in the optical spot 12 for playback So that magneto-optic-recording data medium 10 may carry out a temperature rise gradually by the exposure of the light for playback and it may become beyond the flux reversal temperature Tr to which magnetization is equal to the sense of an external magnetic field Hex as mentioned above in a certain range, as a continuous line t shows to drawing 3 B Moreover, the power of the light for playback is selected so that a maximum temperature may not turn into more than Curie temperature. At this time, magnetization is arranged with the sense of an external magnetic field Hex in the flux reversal field 16 beyond the flux reversal temperature Tr.
[0036] And in the low-temperature field 14 of under the flux reversal temperature Tr, only one information record pit 11A exists in the optical spot 12 for playback in this case, and the shift speed of magneto-optic-recording data medium 10, the material of a magnetic layer 3, etc. are selected so that other information record pit 11B may enter in the elevated-temperature field 13 included to the flux reversal field 16.
[0037] By considering as such a configuration, step will always be kept with magnetization of an external magnetic field Hex and the same direction ** [according to / that information], and change of the magneto-optical effect will be

obtained according to the sense of the magnetization corresponding to the information on information record pit 11A, that is, information record pit 11B in the optical spot 12 for playback can read only this information record pit 11A, and can reproduce a hyperresolution.

[0038] Moreover, also in this case, read information record pit 11A will enter in the elevated-temperature field 13 according to shift of magneto-optic-recording data medium 10, and the sense of magnetization will be arranged with an external magnetic field Hex in here, therefore the information record pit 11 is automatically eliminated after playback. For this reason, when recording information needs to be eliminated after playback for a security protection etc., it is not necessary to establish any elimination means, and simplification of a record regenerative apparatus can be achieved.

[0039] Next, with reference to drawing 4 A and B, other examples of this invention magneto-optic-recording playback method are explained. In drawing 4 A and B, the same sign is given to the portion corresponding to drawing 1 A and B, and duplication explanation is omitted.

[0040] In this case, like the example explained in drawing 3 , although it is made for magneto-optic-recording data medium 10 of the elevated-temperature field 13 to become beyond flux reversal temperature, especially that maximum temperature turns into more than the Curie temperature of a magnetic layer 3, and the case where the magnetization disappearance field 15 is formed in the part in the flux reversal field 16 is shown. Thus, when the magnetization disappearance field 15 where it becomes more than Curie temperature into the flux reversal field 16, and magnetization disappears exists, it also sets. In the elevated-temperature field 13 in the spot 12 which laps like the example explained in above-mentioned drawing 3 with a part of this magnetization disappearance field 15 and flux reversal field 16 or [that magnetization of information record pit 11B is arranged with an external magnetic field Hex] -- or magnetization disappearance will be carried out and a mask will be carried out to information record pit 11A in the low-temperature field 14. Therefore, only one information record pit 11A can be reproduced among two or more information record pits in a spot 12 also in this case, and high density playback can be performed by super resolution.

[0041] Moreover, also in this case, by passing through the flux reversal field 16, like the example explained in drawing 3 , magnetization will be arranged and information record pit 11A will be initialized in an external magnetic field Hex and this direction. Therefore, when recording information needs to be eliminated like an above-mentioned example after performing one playback, simplification of a record regenerative apparatus can be achieved.

[0042] In the example explained by above-mentioned drawing 3 A and B, the optical power for playback was changed and the playback output was measured. First, linear velocity 7 m/s and 10MHz (record wavelength of 0.7 micrometers, 0.35 micrometers of mark length) high density record were performed to magneto-optic-recording data medium 10 of a configuration of having explained in drawing 2 .

[0043] On the other hand, the playback output was not obtained when the optical power for playback was reproduced as 1.5mW. The cut-off record wavelength lambda which is the inverse number of a cut off frequency is lambda= 780nm, numerical aperture NA is 0.53, and since this is cut-off spatial-frequency lambda/2NA=0.74micrometer, it is based on the ability of re-nature of the record of 0.7-micrometer wavelength shorter than this not to be carried out.

[0044] Next, the optical power for playback was raised to 3.0mW, and when it reproduced impressing 300Oe(s) for an external magnetic field Hex with the magnetic field generating means 9, the C/N=35dB playback output was obtained.

[0045] The playback output was not obtained when it reproduced by the same method as above-mentioned conditions after this playback actuation. This is based on magnetization having been arranged for the information pit by the external magnetic field, and having been initialized, as explained in above-mentioned drawing 3 .

[0046] That is, while being able to perform record playback of super resolution to magneto-optic-recording data medium of an easy magnetic layer configuration by impressing a playback magnetic field in this case, and making power of that light for playback into size as compared with the conventional method substantially Record can be eliminated without establishing any elimination means, when recording information needs to be eliminated once especially after playback by making the playback actuation into a limitation, and simplification of equipment can be achieved.

[0047] In addition, this invention method can take various equipment configurations, such as making the sense of an external magnetic field Hex into the reverse sense, and the other playback methods in the example explained, for example in drawing 3 and drawing 4 , without restricting to an above-mentioned example.

[0048]

[Effect of the Invention] Since recording information is automatically eliminated after playback according to this invention magneto-optic-recording playback method, without taking time and effort, such as eliminating a recording track and going, using a special magnetic eraser, when these contents of record need to be eliminated after that for a security protection etc. although only especially one playback is needed as mentioned above, simplification of a record regenerative apparatus can be achieved.

[0049] furthermore, record playback of the super resolution more than cut-off spatial frequency can be performed, moreover, it can be markedly alike as compared with magneto-optic-recording data medium which uses the magnetic layer of the magneto-optic-recording data medium for the record playback methods, such as the conventional MSR method, and an easy configuration can be taken.

[Translation done.]